Statement of Work

Assessment of Automobile Start and Idling Emissions under Utah Specific Conditions
(July 15, 2014 – September 31, 2015)

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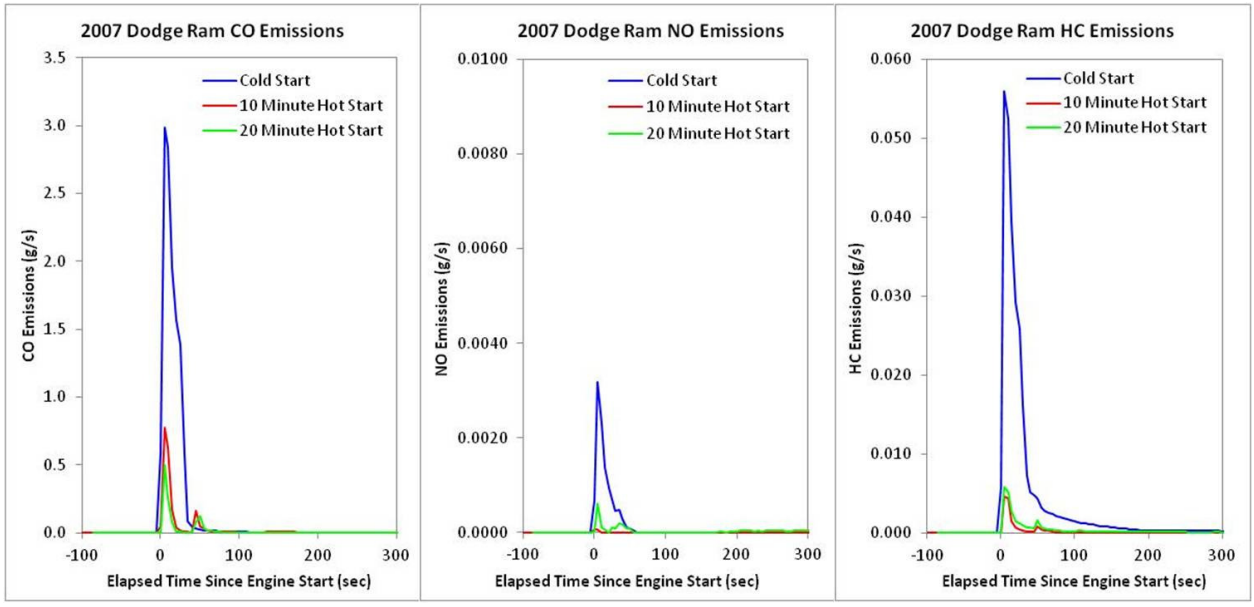
Problem Statement

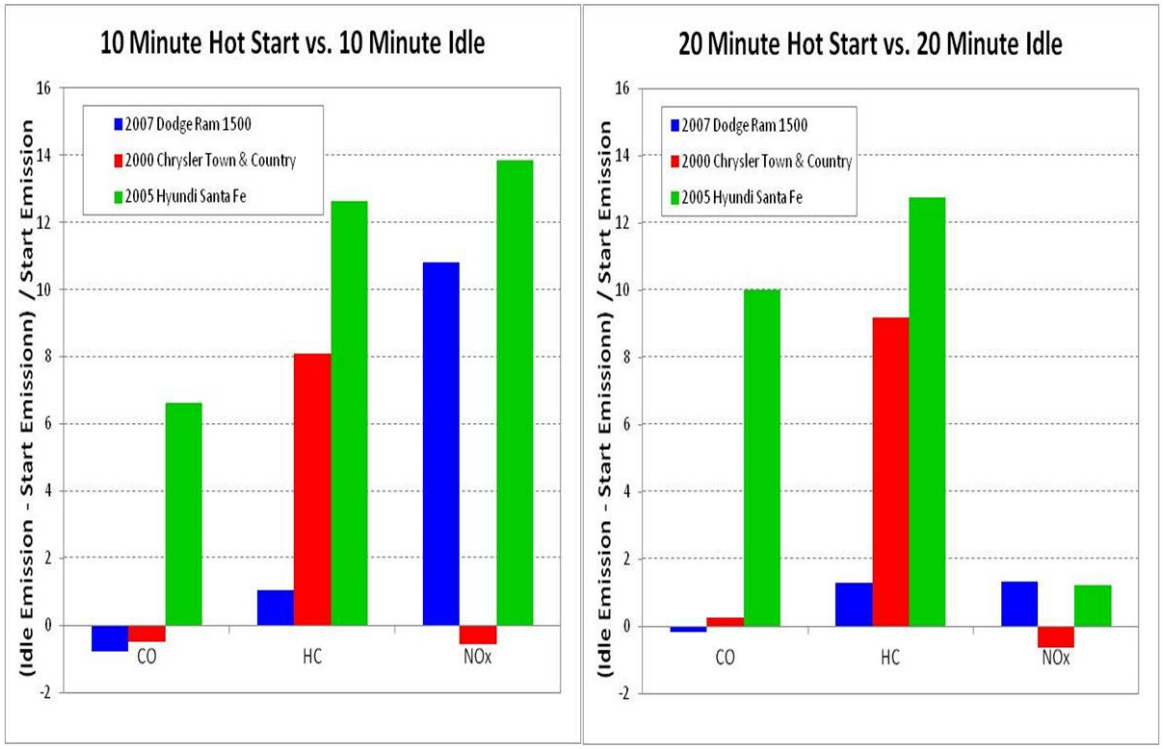
Most of Utah's SIPs rely on mobile source control for significant airshed reductions in oxides of nitrogen (NOx) and hydrocarbons or volatile organic compounds (VOCs or HCs), including programs to address cold starts and anti-idling ordinances and public awareness campaigns. However, little literature and data exist identifying the benefits or atmospheric penalties involved with these issues, particularly under Utah-specific conditions (vehicle fleet, temperature regimes, etc.). A limited laboratory study of start and idling emissions last year at USU (3 vehicles) found 10 and 20 minute start emissions for NOx and VOCs were 1.1 and 2.0% and 7.2 and 3.5%, respectively, of the cold start emissions. Figure 1 shows sample cold and hot start emission measurements of carbon monoxide (CO), oxides of nitrogen (NO_x), and hydrocarbons (HC) for a 2007 Dodge Ram 1500 pickup truck (126,000 miles, 5.8 L engine).

Figure 1. Pollutant emissions comparisons of cold start, 10-min hot start, and 20-min hot start for a 2007 Dodge Ram Pickup Truck.



Additionally, the brief study found that compared to continuous idling, hot start emissions were found to result in lower emissions by -60 to +1,400% for NO_x and HCs across the vehicles tested (see Figure 2). The information gathered from this limited study revealed a need for further in-depth evaluation utilizing a large vehicle fleet and more sophisticated instrumentation.

Figure 2. Relative pollutant emissions comparing hot start (10 and 20 min) and equivalent idle times.



Scope of Work

1. Researchers at the Utah State University (USU) and National Center for Automotive Science and Technology at Weber State University (NCAST) will collaborate to assess the emission differences between engine cold starts, hot starts, and continuous idling. We will also be looking to answer whether cold start emissions are higher in a colder environment as well as how long a catalytic converter is able to remain at an optimal temperature during winter and summer conditions after the engine is shut off. Planned test protocols will include:

- Cold start: both static (idle until equilibrated) and dynamic (a cold start followed immediately by simulated drive cycle on a dynamometer) – emissions will be monitored until an observed equilibrium is approached (i.e. asymptotic)

- Hot start: performing a drive cycle until the engine and catalytic converter have reached nominal operating temperatures, followed by an engine shut off and restart after pre-determined time increments (e.g. 5 min, 10 min, etc.)

- Idle: after warm up/drive cycle, monitor vehicle emissions under continuous idle for 5-15 minutes

2. Instrumentation will be compiled and readied in summer of 2014, and data collection will begin during late fall and continue through winter, spring, and potentially early summer of 2015.

    - NO_x, HCs, and CO (carbon monoxide) concentrations will be monitored with an Autologic 5-Gas Analyzer (or equivalents). Supporting data will also be recorded including system temperatures, flow rates, RPMs, and drive cycle conditions using manufacturer specific and/or generic scantools. Vehicles will be tested under load using a laboratory grade transient chassis dynamometer.

    - Vehicles being tested will represent the current Wasatch Front and Cache County fleets.

3. Utah State University and NCAST researchers will be available for meetings/conference calls with UDAQ and other regulatory or legislative personnel.

Schedule, Cost, and Team Roles

The proposed schedule is 15 months (July 2014- September 2015) at a total cost to USU of $95,000. Costs associated with NCAST's portion of this study are detailed un der a separate SOW and contract with UDAQ. Specific milestones are:

- October 31, 2014: Test protocols finalized, including supply and instrument purchases, system design, and equipment verification and calibration
- November 2014 – April 2015: Vehicle emission testing at USU and NCAST/WSU
    - December 31, 2014: Interim report to UDAQ
    - March 31, 2105: Interim report to UDAQ
    - June 30, 2015: Interim report to UDAQ
- October 1, 2015: Submission of final report to UDAQ

It is anticipated that the investigators will additionally be available for extracurricular presentations to the UDAQ or other groups as required.

The budgetary breakdown for the USU requested funds is shown below in Table 1. Dr. Randy Martin (USU) will service as the project PI and Joe Thomas (WSU, DAQ) will service as the project co-PI and

NCAST liaison. A USU graduate student, as well as undergraduate students at USU and WSU will be heavily involved with the project.

Table 1. USU Budget July 15, 2014 – September 30, 2015.

Personnel: PI (Dr. Randy Martin 1.25 months)	$11,100
Personnel: Students (12 mo. Grad. & 700 hrs Undergrad)	$30,160
Benefits: Faculty 46%, Student 8.2%, Student Insurance	$8,766
Travel: multiple trips to SLC and Weber	$2,500
Materials & Supplies	$12,232
Env. Quality Lab Usage & Tuition	$16,765
Capitol Equipment (Autogas 5-Gas Analyzer)	$6,200
Allowable Indirect Costs (10% of all non-equipment costs)	$7,277
Total Direct Costs	$87,724
Total Budget	**$95,000**

Deliverables

1. The ultimate product will be comparisons across a wide selection of vehicles for emissions of NOx, HCs, and CO, in units of mass per time (e.g. g/s) as a function of the start and idle conditions listed above.

2. All data collected will be stored at Utah State University and made accessible via web-based interfaces in convenient formats to DAQ and other researchers, as requested.

3. A final project report will be provided detailing the sampling protocols, the data collected, and the ultimate analysis. Additionally, it is anticipated that the project will be coalesced into a peer-reviewed publication.

    - As part of the final report, the observed emissions data will be compared to assumed local automobile emission rates calculated by EPA's approved MOVES model (e.g. MOVES model outputs as used in local and regional photochemical models). This analysis will include discussion on how any found emissions differences could potentially impact ultimate $PM_{2.5}$ and/or ozone formation behaviors or concentrations as predict by the aforementioned models.